



Naval Postgraduate School Total Ship Systems Engineering Program

Arsenal Ship Student Design Summary

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NPS TSSE Program

Objective

Provide a broad based, systems engineering
and design oriented curriculum....
focusing on the warship as a total engineering
system....
including hull, mechanical, electrical
(HM&E) and combat systems.



TSSE and Arsenal Ship

“I want you to do an Arsenal Ship design because I’d like to have it looked at by a knowledgeable Navy person with input from young, innovative officers”*

Honorable John Douglass
ASN (RD&A)
at NPS, March 1996



THE PEOPLE

15 Students

– Service

10 USN

1 Aviator

1 Surface Warfare Officer

6 Engineering Duty Officers
(former SWO)

2 Engineering Duty Officers
(former Sub)

4 USCG naval engineers

1 USMC infantry/light armor officer

– Curriculum/Degree

7 Naval/Mechanical eng

4 Combat Sys Science

4 Elect Sys Eng

Coaches:

Assoc. Prof. Calvano (Ship Design/HM&E)

Assoc. Prof. Harney (Combat Systems)

Problem Statement

- ◆ First Iteration of a design for an Arsenal Ship
- ◆ Primary Constraints
 - 550 Million dollars Unit Sailaway Price
 - 50 Crew Max
 - Nearly Unsinkable Survivability
 - 22 kt. Sustained Speed
 - Approximately 500 Missile Cells

Design Philosophy (Priorities)

- ◆ Acquisition Cost and Life Cycle Cost
- ◆ Mission Effectiveness
- ◆ Survivability and Self Defense
- ◆ Reduction in Manning
- ◆ Reliability, Maintainability and Availability
- ◆ Commonality: Other Platforms, Commercial off the Shelf (COTS), and Exploiting DoD Investments
- ◆ Upgradeability and Modularity
- ◆ Minimized Maintenance
- ◆ Environmental Impact
- ◆ Habitability



Manning Considerations

- ◆ Watchstander/Maintainer approach to basic manning
 - Commercial ship basis; justify additions
- ◆ Minimization of special evolutions
 - “Oiler” design left sufficient tankage for 75,000 nm @ 15 kts
 - No need to refuel at sea
 - Manpower and dollar savings (eliminate associated systems)
 - No traditional deck gear (anchoring systems, boat davits, etc.)
 - Keel-mounted anchor w/ internal machinery
 - Single RIB with launching crane housed in superstructure
- ◆ High degree of dependency on automation



Manning Considerations

- ◆ “Blue/Gold” approach to crew assignment
 - Crew integrity maintained
 - Eighteen month commitment to program
 - “Arsenal Ship School” for off-ship training and BG workups
- ◆ Recognition of need for selective screening of crew
 - Senior enlisted cadre; few “apprentices”
 - “Arsenal Ship School” role
- ◆ Admin ashore at base
- ◆ Off watch crew DC party concept

Manning-Reduction Automation

- ◆ Integrated Bridge System (IBS)
- ◆ Standard Monitoring and Control System (SMCS)
- ◆ Damage Control System(DCS)
- ◆ Integrated Condition Assessment System (ICAS)
- ◆ Two Wire Automatic Remote Sensing Evaluation System



Table of Organization

LINE #	BILLET	RANK	QUANTITY	WATCHSTANDER	COMMENTS
1	CAPTAIN	O-5	1	NO	
2	EXECUTIVE/MAINTENANCE OFFICER	O-4	1	YES	CSOW
3	WEAPONS OFFICER	O-4	1	YES	CSOW
4	OFFICER OF THE DECK	O-3	4	YES	DEPARTMENT HEADS
5	JOOD	E-7/8	4	YES	DIVISION OFFICERS
6	COMM SPECIALIST	E-5/6	4	YES	
7	ENGINEERING OFFICER OF THE WATCH	E-7/8	4	YES	DIVISION OFFICERS
8	EW SPECIALIST	E-5/6	4	YES	
9	DECK FORCE	E-5/6	5	NO	
10	HM&E FORCE	E-4/5	5	NO	
11	COMBAT SYSTEM FORCE	E-4/5/6/7	8	NO	ONE E-7 & SEVEN E-4/5/6
12	CORPSMAN	E-5/6	1	NO	
13	MESS SPECIALIST	E-4/5/6	2	NO	ONE E-5/6 & ONE E-4/5
		OFFICER	7		
		CHIEFS	9		
		ENLISTED	28		
			44		

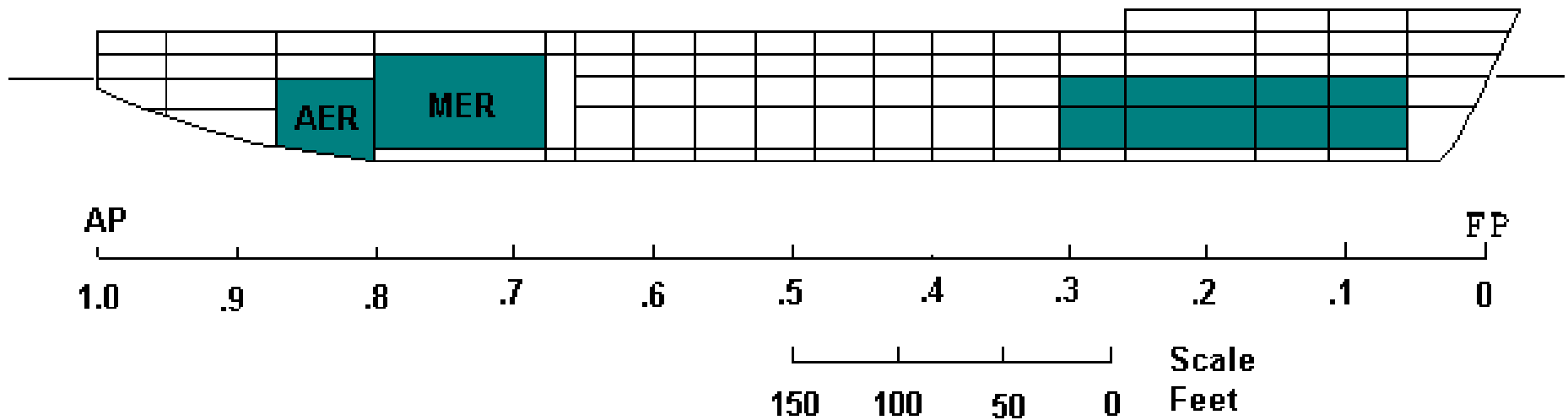
Survivability Features (1)

- ◆ Detonation of 32 or 64 VLS/CCL is overmatching damage
 - Eight-cell unit max desirable to avoid ship-threatening damage
- ◆ 64 installations of 8 cells, with protection and separation
- ◆ This takes real estate
- ◆ Drives to larger ship
- ◆ Modified repeat of AO 201 double hull tanker
 - Sufficient deck space
 - Synergistic impacts
 - Mass/tonnage
 - double hull

Survivability Features (2)

- ◆ Eight-cell launcher modules in 1” armor boxes
 - Standoff from box to cells
 - Separation between boxes
- ◆ Use of Concentric Canisterized Launcher (vice VLS)
 - Improved Shock; deck collar vice bottom foundation
 - Improved fragmentation/anti-fratricide features
- ◆ Double hull used for concrete “side armor”
- ◆ Severe reduction of topside mass and clutter
- ◆ Use of Foam-in-Salvage as damage mitigation mechanism

Foam in Salvage Coverage



Survivability-Related Naval Architectural Features

- ◆ Double Hull Design
- ◆ Missile Cell Separation
- ◆ 17 Transverse Bulkheads
- ◆ Concrete Ballast as Armor in Double Hull
- ◆ Reduced Signature

Arsenal Ship Combat System

- ◆ SM-2, TLAM, ATACM, VGAS
- ◆ Concentric Canisterized Launcher
- ◆ CEC/link 16/link 22
- ◆ C4I: Joint Maritime Communications Strategy
- ◆ SSDS, RAM, Nulka, IR decoys, Rubber Duck, AIEWS

Remote Firing Capability

- ◆ Response times equivalent to control ship
- ◆ Seamless joint operations
- ◆ Must allow for simultaneous control of missiles from multiple platforms
- ◆ Cooperative Engagement Capability
- ◆ Advanced *Tactical* Weapon Control System
- ◆ Vertical Launching System

CEC

-
- ◆ Provides necessary bandwidth
 - ◆ Proven reliability
 - ◆ Known hardware
 - ◆ Easily modified to handle different data types (processor)

ATWCS

-
- ◆ Next generation weapon control system
 - ◆ Open architecture, COTS
 - ◆ Expanded storage capacity
 - ◆ Ethernet networks and fiber optics
 - ◆ Accommodate all missiles and guns
 - ◆ Supports time critical data

Network

- ◆ Survivable Adaptable Fiber Optic Embedded Network (SAFENET) and Fiber Distributed Data Interface (FDDI)
- ◆ 100 Mbytes/sec, 240 taps
- ◆ Cheap, commercial availability/standards
- ◆ Government Open System Interconnection Profile (GOSIP)

Propulsion Plant

- ◆ COLT PIELSTICK 4.2V18
- ◆ 30,000 HP INSTALLED
- ◆ MECHANICAL TRANSMISSION
- ◆ PTO 2500 KW
- ◆ CONTROLLABLE PITCH PROPELLERS
 - twin screw

Electrical Plant

- ♦ AC POWER GENERATION
- ♦ ZONAL DISTRIBUTION 15 ZONES 3 BUSSES
- ♦ 2 SS POWER TAKE OFF GENERATORS
- ♦ 3 SS DIESEL GENERATORS
- ♦ 12,500 KW INSTALLED

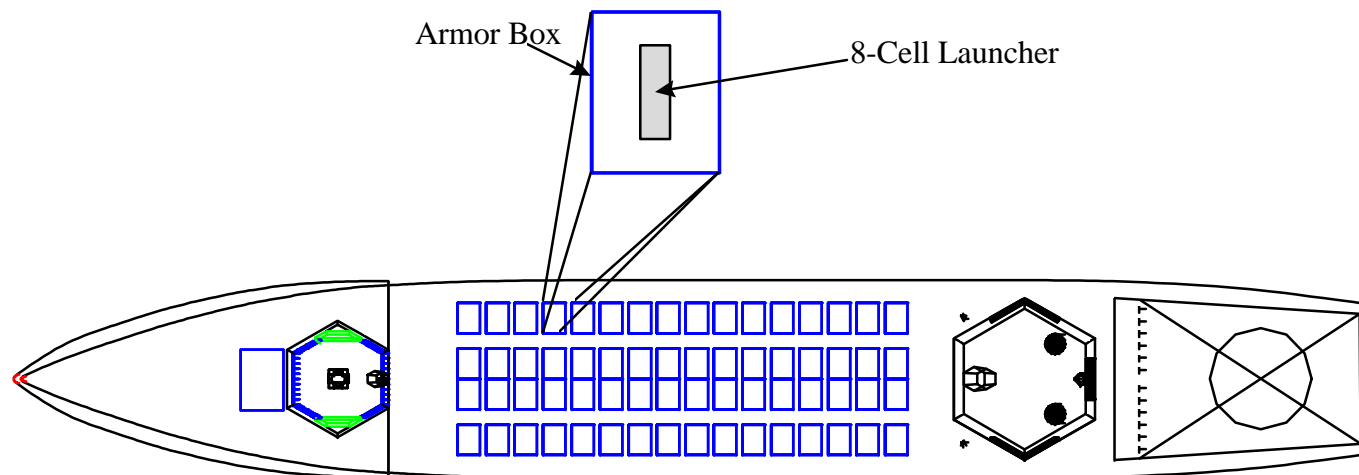


Arsenal Ship Characteristics

◆ LOA	667 ft	◆ Beam	97 ft
◆ Draft	34 ft	◆ Displacement	39,500 LT
◆ Range	75,800 nm	◆ Floodable Length	3 Compts
◆ Endurance	210 Days	◆ KG	29.75 ft
◆ Installed SHP	57,750 HP	◆ GM	11.20 ft

USNS T-AO CLASS Oiler

Arsenal Ship



Arsenal Ship

